

## An annotated census of the mosses of the Perth Region, Western Australia

Louise J. Biggs<sup>1,2</sup> and Jennifer A. Chappill<sup>1,†</sup>

<sup>1</sup>School of Plant Biology, University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009

<sup>2</sup>Western Australia Herbarium, Department of Environment and Conservation, Locked Bag 104,  
Bentley Delivery Centre, Western Australia 6983

<sup>†</sup>Deceased August 8th 2006

### Abstract

Biggs, L.J. & Chappill, J.A. An annotated census of the mosses of the Perth Region, Western Australia. *Nuytsia* 18: 1–30 (2008). A census of the moss species of the Perth Region is based on field studies and collections housed at the Western Australia Herbarium (PERTH). It includes 83 taxa in 45 genera and 21 families. The largest families recorded were Pottiaceae and Bryaceae. Two species not previously recorded for Western Australia, *Leptobryum pyriforme* (Hedw.) Wilson and *Pohlia nutans* (Hedw.) Lindb., are included.

### Introduction

Bryophyte collections in the Perth Region began along the Swan River shortly after the British settled in Fremantle in 1829 (Stoneburner *et al.* 1993). The most significant contributors were James Drummond (1784–1863) who collected extensively from the south-west region of Western Australia, sending specimens to England, and the German botanist Ludwig Preiss (1811–1883) (Marchant *et al.* 1987).

Since the 19th century there have been a number of census catalogues including, or focusing on, Western Australian mosses (Hampe 1844; Mitten 1883; Watts & Whitelegge 1902; Bartram 1951; Willis 1954; Scott & Stone 1976), with the most recent (Stoneburner *et al.* 1993) citing 192 taxa including 30 new State records.

Western Australia is Australia's largest State, occupying over one third of the area of the continent, yet only 212 moss species have been recorded, a surprisingly low number. The Australian Capital Territory, by comparison, is only 2,400 km<sup>2</sup> in area but has 208 species (Streimann & Klazenga 2002). Western Australia is largely extremely dry and arid with low rainfall and humidity levels. These factors play a role in the low species diversity of Western Australian mosses. Another possible contributor is that surveys of such a large area are time consuming and therefore have not been accomplished to the same extent as those of the smaller Eastern States. The collection of the new species *Pleurophascum occidentale* R.E. Wyatt & A.H. Stoneb. in 1984 suggests that there are still more mosses to be discovered in Western Australia.

The Perth Region lies primarily on the Swan Coastal Plain, with the Swan River flowing directly through the area. Soils are of aeolian origin, consisting of shallow sandy soils over calcareous rock. This supports a number of vegetation types including coastal dunes, heathlands, woodlands, and shrublands of *Acacia*, *Banksia*, *Melaleuca* and eucalypts. Topography is low with the highest point only 60 m above sea level. Climate is described as mediterranean with hot, dry summers and cold, wet winters. Average annual rainfall for 1997–2007 was 731.88 mm with the highest rainfall recorded in 2005 with 874.8 mm and the lowest annual rainfall recorded in 2006 at 466.8 mm. Average monthly temperatures in 2006 ranged from 5.8 °C in winter to 30.4°C in summer.

## Methods

In this study the boundary used for the Perth Region follows that of Marchant *et al.* (1987). The area included is approximately 10,500 km<sup>2</sup> and extends from the coastline west of Boyanup in the south, to Guilderton in the north, with the most easterly point at Wooroloo.

Over 700 collections from the Western Australian Herbarium (PERTH), together with additional field collections from Bold Park in Floreat and Kings Park in West Perth have been included in the survey, with each specimen being re-examined and identified for this paper. Nomenclature follows Streimann and Klazenga (2002) and McCarthy (2006). Families are listed alphabetically, as are the taxa within. Capsule descriptions have not been provided for all taxa herein as they are either uncommon for the species or have not been present during collections.

## Results and Discussion

The census includes 83 species in 21 families and 45 genera (Table 1). Pottiaceae, with 19 species, and Bryaceae, with 16 species, are the most strongly represented families. These families also contained the most species in Stoneburner *et al.*'s (1993) census of Western Australian mosses. This is not surprising as they are well known inhabitants of arid ecosystems, often forming part of soil crusts along with lichens, cyanobacteria, algae and fungi, stabilizing the soil, reducing erosion and increasing soil nutrition (Eldridge & Tozer 1997). Fifteen species known from the Perth Region are not currently represented by collections at the Western Australian Herbarium.

There are currently reported to be 304 endemic species of moss (Streimann & Klazenga 2002) in Australia. Nine species and two infraspecific (of a total of 304 *vide* Streimann & Klazenga 2002) Australian endemic taxa are represented in the Perth Region: *Bartramia hampeana* Müll.Hal. subsp. *hampei* (Mitt.) Catches., *Campylopus australis* Catches. & J.-P.Frahm, *Campylopus flindersii* Catches. & J.-P.Frahm, *Dicranoloma diaphanoneuron* (Hampe & Müll.Hal.) Paris, *Fabronia hampeana* Sond., *Gemmabryum austrosabulosum* (Catches. ex J.R.Spence & H.P.Ramsay) J.R.Spence & H.P.Ramsay, *Gemmabryum inaequale* (Taylor) J.R.Spence & H.P.Ramsay, *Gemmabryum sullivanii* (Müll.Hal.) J.R.Spence & H.P.Ramsay, *Leptodontium paradoxum* I.G.Stone & G.A.M.Scott, *Philonotis australiensis* D.G.Griffin & W.R.Buck and *Thuidium sparsum* (Hook.f. & Wilson) A.Jaeger var. *hastatum* (Mitt.) Touw & Falter-van den Haak.

*Fabronia hampeana* is endemic to Western Australia and the Perth Region. Two further Western Australian endemic species, *Calymperastrum latifolium* (Hampe) I.G.Stone and *Pleurophascum occidentale* have been found in the Denmark area of the south-west, outside the Perth Region. This

**Table 1.** Moss families and genera of the Perth Region, Western Australia.

<b>Family</b>	<b>Genus</b>	<b>Species</b>
<b>Archidiaceae</b>	<i>Archidium</i>	1
<b>Bartramiaceae</b>	<i>Bartramia</i>	3
	<i>Breutelia</i>	1
	<i>Philonotis</i>	2
<b>Bryaceae</b>	<i>Bryum</i>	2
	<i>Gemmabryum</i>	8
	<i>Ptychostomum</i>	1
	<i>Rosulabryum</i>	5
<b>Dicranaceae</b>	<i>Campylopus</i>	4
	<i>Dicranoloma</i>	1
<b>Ditrichaceae</b>	<i>Ceratodon</i>	1
	<i>Ditrichum</i>	1
	<i>Eccremidium</i>	4
	<i>Pleuridium</i>	2
<b>Fabroniaceae</b>	<i>Fabronia</i>	1
<b>Fissidentaceae</b>	<i>Fissidens</i>	6
<b>Funariaceae</b>	<i>Entosthodon</i>	3
	<i>Funaria</i>	1
<b>Gigaspermaceae</b>	<i>Gigaspermum</i>	1
<b>Grimmiaceae</b>	<i>Grimmia</i>	2
<b>Hedwigiaceae</b>	<i>Hedwigia</i>	1
	<i>Hedwigidium</i>	1
<b>Meesiaceae</b>	<i>Leptobryum</i>	1
<b>Mniaceae</b>	<i>Pohlia</i>	1
	<i>Schizymerium</i>	1
<b>Orthodontiaceae</b>	<i>Orthodontium</i>	1
<b>Orthotrichiaceae</b>	<i>Zygodon</i>	1
<b>Pottiaceae</b>	<i>Barbula</i>	3
	<i>Bryerythrophyllum</i>	1
	<i>Didymodon</i>	2
	<i>Gymnostomum</i>	1
	<i>Leptodontium</i>	1
	<i>Syntrichia</i>	3
	<i>Tetrapterum</i>	1
	<i>Tortella</i>	1
	<i>Tortula</i>	2
	<i>Trichostomum</i>	1
	<i>Triquetrella</i>	1
	<i>Weissia</i>	2
<b>Racopilaceae</b>	<i>Racopilum</i>	1
<b>Rhabdoweisiaceae</b>	<i>Amphidium</i>	1
<b>Sematophyllaceae</b>	<i>Rhaphidorrhynchium</i>	1
	<i>Sematophyllum</i>	2
<b>Splachnaceae</b>	<i>Tayloria</i>	1
<b>Thuidiaceae</b>	<i>Thuidium</i>	1

number of endemic mosses is extremely low when 75% of vascular plants in the south-west are endemic (Hopper 1979). *Rhacocarpus rehmannianus* (C.Muell.) Wijk & Margad. var. *webbianus* (Müll.Hal.) J.P.Frahm was earlier thought to be a Western Australian endemic but has also been reported from South Australia (Stoneburner *et al.* 1993; Streimann & Klazenga 2002).

*Calymperastrum latifolium* has a conservation status of Priority Two under the Department of Environment and Conservation's (DEC) Conservation Codes for Western Australian Flora (Atkins 2008). This listing is given when taxa are known from one or a few (generally <5) populations, are not currently critically endangered, and are under consideration for declaration as 'Rare Flora' and in need of further research. *Pleurophascum occidentale* has a status of Priority Four, meaning that while adequate surveying has been undertaken it is considered rare, although not currently threatened by any identifiable factors. These taxa are monitored every 5–10 years (Atkins 2008). *Rhacocarpus rehmannianus* var. *webbianus* is considered rare under the *Western Australian Wildlife Conservation Act 1950*, meaning it has been adequately searched for and deemed to be rare and in danger of extinction or in need special protection. To date none of these species have been located in the Perth region.

## Census

### Archidiaceae

**Archidium rehmannii** Mitt., *J. Linn. Soc., Bot.* 22: 300. 15 f. 5–8 (1886).

First collected in Western Australia by Wyatt and Stoneburner from swampy areas on bare sand at Cannington Swamp. The plants are short, up to 15 mm tall, with numerous stiffly erect innovations or branches arising from below the shoot apices. The leaves are narrowly lanceolate, to 1.5 mm long, and the costa is broad. Capsules appear to be rare in Australian material. Elsewhere known only from southern Africa.

Represented by one collection from the study area.

### Bartramiaceae

**Bartramia breutelii** Schimp. ex Müll.Hal., *Bot. Zeitung (Berlin)* 16: 162 (1858).

Bell (2006) included five species of *Bartramia* Hedw. in the moss flora of Western Australia: *B. breutelii* Müll.Hal., *B. hampeana* subsp. *hampei* (Mitt.) Catches., *B. pseudostricta* Catches., *B. robusta* Hook.f. & Wilson, and *B. strictifolia* Taylor. *Bartramia afrostricta* Müll.Hal. was included in the Western Australian flora by Catcheside (1987) but synonymised by Magill (1987) in *Anacolia* Schimp. as *A. breutelii* (Müll.Hal.) Magill. However, Bell (2006) has taken a more conservative approach to the generic placement of this taxon, retaining it in *Breutelia* pending more detailed investigation. The nomenclatural confusion surrounding *B. strictifolia* and related taxa is discussed by Catcheside (1987).

*Bartramia breutelii* and *B. strictifolia* both have linear-lanceolate leaves with sheathing bases. *Bartramia pseudostricta* also has linear-lanceolate leaves but these lack a sheathing base. Plants of *B. breutelii* are 1–4 cm tall, yellow-green above, brownish green below, leaves erect, closely appressed when dry, 3–4.5 mm long and 0.6–0.9 mm wide. Plants of *B. strictifolia* are generally less than 1.0 cm tall, pale yellowish green above, brown below, with leaves closely appressed when dry, 2.7–3.5 mm long and 0.6–0.75 mm wide.

The type collection of *B. strictifolia* is from ‘Swan River’, collected by J. Drummond, who also made an early collection of *B. breutelii* from ‘Swan River’.

Represented by two collections from the study area.

***Bartramia hampeana*** Müll.Hal. subsp. ***hampei*** (Mitt.) Catches., *Lindbergia* 29: 89 (2004).

*Bartramia hampei* (Mitt.) Catches., *Mosses of South Australia* 281 (1980).

Catcheside (1980) transferred *Bartramidula hampei* Mitt., to *Bartramia*. He considered that while this taxon was similar to *Bartramia papillata* Hook.f. & Wilson, the stems were generally shorter (less than 1 cm long), the leaves less widely spreading and the lamina cells narrower. He also stated that it was difficult to separate *B. hampeana* from *B. papillata* without capsules. Bell (2006) noted that while *B. hampeana* lacked a peristome, in order to differentiate it from the peristomate *B. robusta* Hook.f. & Wilson (syn. *B. papillata*), young capsules needed to be examined as the peristome was soon lost. Matteri (1984) reduced *B. papillata* to a synonym of *B. ithyphylla* Brid. Bell (2006) considered this species synonymous with *B. robusta*.

The leaves of *B. hampeana* and *B. robusta* have a sheathing base and linear-lanceolate upper lamina. Plants of *B. hampeana* subsp. *hampei*, which is endemic to Australia, are less than 1 cm tall and dull brown to yellowish green; leaves are suberect, with an oblong sheathing base and linear-lanceolate upper limb, 2–5.5 mm long, 0.4–0.5 mm wide. Plants of *B. robusta* are up to 3 cm tall and yellowish green; leaves have a sheathing base and linear-lanceolate upper limb, are 3.5–6.5 mm long, 0.5–1.0 mm wide, and the limb is wide-spreading from the sheathing base.

Represented by two collections from the study area.

***Bartramia pseudostricta*** Catches., *Mem. New York Bot. Gard.* 45: 621 (1987).

Plants form loose tufts that are glaucous-green above and brownish below. The stems are short with the plants only up to 1 cm tall. The leaves are linear-lanceolate, erect-spreading and flexuose, and lack a sheathing base. So far the species is only known from south-west Western Australia and the Flinders and Mount Lofty Ranges in South Australia. It has been found growing in small patches on soil over rock.

Represented by three collections from the study area.

***Breutelia affinis*** (Hook.) Mitt., *Hooker’s J. Bot. Kew Gard. Misc.* 8: 261 (1856).

Only one species of *Breutelia* has been reported from Western Australia. It is easily recognised by its long (to 5 cm or more) stems that are usually branched near the apex, tomentose stems with brown

hairs and leaves that are erect-spreading, ovate-lanceolate to oblong-lanceolate and have longitudinally pleated bases. Microscopically, the species is readily distinguished from other Australian species by the leaves, which have numerous quadrate alar cells that extend to about 1/3 of the leaf length.

Represented by two collections from the study area.

**Philonotis australiensis** D.G.Griffin & W.R.Buck, *Bryologist* 92: 376 (1989).

*Bartramidula pusilla* (Hook.f. & Wilson) Paris, *Index Bryol.* 116 (1894).

Minute plants, reaching only to about 5 mm high. Leaves are pale to whitish green, ovate-lanceolate to linear-lanceolate, and mostly less than 0.5 mm long. The globular to oblong, erect to pendulous capsules are borne on an erect seta up to 10 mm tall. This species is endemic to Australia.

Represented by two collections from the study area.

**Philonotis tenuis** (Taylor) Reichardt, *Reise Novara* 1(1): 178 (1870).

A plant of damp to wet sheltered sites, forms dense tufts with the stems to 3 cm or more tall and matted below with brown tomentum. The leaves are triangular-lanceolate to ovate-lanceolate, 0.5–1.5 mm long.

Represented by three collections from the study area.

## Bryaceae

Bryaceae represents one of the larger moss families, with 15 genera and around 600 species, and is a family that has provided, and continues to provide, considerable taxonomic challenges (Spence & Ramsay 2006). Ochi (1970, 1972, 1973, 1985) based his studies of Australian Bryaceae on herbarium material only. More recently, Spence (1996, 2005), and Spence and Ramsay (1996, 1999, 2005, 2006) have included extensive field studies. Nomenclature used here follows Spence and Ramsay (2006).

**Bryum argenteum** Hedw., *Sp. Musc. Frond.* 181 (1801).

A common and cosmopolitan species, *B. argenteum* is frequently found in urban areas on soil, on pavements, on walls, rocks etc. Plants form patches, with the shoots densely packed and silvery green. Asexual bulbils are commonly found in the leaf axils of sterile shoots. Spence and Ramsay (2006) consider it possible that the species has been introduced to Australia.

Represented by 11 collections from the study area.

**Bryum lanatum** (P.Beauv.) Brid., *Muscol. Recent. Suppl.* 3: 20 (1817).

*Anomobryum lanatum* (P.Beauv.) J.R.Spence & H.P.Ramsay, *Teloepa* 9: 785 (2002).

Like *B. argenteum*, this species is whitish green and forms dense tufts. It is often treated as a variety of *B. argenteum*. The leaf costa of *B. lanatum* is excurrent into a long hyaline hairpoint. Although Spence and Ramsay (2006) consider the hair-pointed leaves to merit specific status, intermediate forms are frequently encountered, and the retention of these as distinct species remains equivocal.

Represented by four collections from the study area.

**Gemmabryum australe** (Hampe) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 65 (2005).

*Bryum australe* Hampe, *Icon. Musc.* 26 (1844).

Forms low golden or brownish green tufts. A rare species of silty soils in open habitats, it is characterised by the stiffly erect, closely imbricate and bristle-like leaves, the costa excurrent as a long hairpoint, the leaf margins strongly recurved and the small, swollen, purple capsules (Spence & Ramsay 2006).

The type specimen was collected by L. Preiss from 'Swan River', Western Australia.

Represented by one collection from the study area.

**Gemmabryum cheelii** (Broth.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 65 (2005).

*Bryum cheelii* Broth., *Proc. Linn. Soc. New South Wales* 4: 591 (1916).

Endemic to Australia, plants are up to 2.5 cm tall and form medium-sized, glossy red to reddish tinged tufts on rock. The leaves are 2–3.5 mm long, stiff, densely imbricate and ovate to oblong-lanceolate. The leaf margin is recurved, serrulate near the apex and lacks a differentiated border. Spence & Ramsay (2006) state that the species appears to be close to the Northern Hemisphere *Imbribryum muehlenbeckii* (Bruch & Schimp.) N.Pedersen.

Represented by one collection from the study area.

**Gemmabryum chryseuron** (Müll.Hal.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 66 (2005).

*Bryum chryseuron* Müll.Hal., *Bot. Zeitung (Berlin)* 9: 549 (1851).

Forms loose to dense, glossy yellowish green to yellowish brown tufts that are often tinged with red. The glossy, golden green leaves with long hairpoints are distinctive. The species also produces abundant, red-coloured, rounded tubers.

The type specimen was collected by J. Drummond from 'Swan River', Western Australia.

Represented by two collections from the study area.

**Gemmabryum dichotomum** (Hedw.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 66 (2005).

*Bryum dichotomum* Hedw., *Sp. Musc. Frond.* 183, pl. 42: f. 8–12 (1801).

A common species of wetter soils. Plants form brown to yellowish green tufts, often bearing numerous bulbils in the leaf axils. The production of numerous bulbils makes this an effective early colonist.

The type specimen was collected by J. Drummond from 'Swan River', Western Australia.

Represented by three collections from the study area.

**Gemmabryum inaequale** (Taylor) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 67 (2005).

*Bryum inaequale* Taylor, *London J. Bot.* 5: 53 (1846).

Plants are small, up to 10 mm tall, the leaves green to yellowish green and glossy. The leaves are imbricate, erect-spreading when moist, appressed when dry, and form comal tufts. Spence and Ramsay (2006) state that the species is often found on vertical earth banks. The collections have come from a variety of habitats, including crevices in rock, on soil, along drainage ditches and the edges of small streams, mostly from moister sites. The species is endemic to Australia.

The type specimen was collected in 1843 by J. Drummond from 'Swan River', Western Australia.

Represented by five collections from the study area.

**Gemmabryum pachythemum** (Müll.Hal.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 64 (2005).

*Bryum pachythemum* Müll.Hal., *Syn. Musc. Frond.* 1: 307 (1848).

The plants form mats or tufts and are golden to reddish green. The pendant capsules are about 2 mm long, purple to crimson-brown and have the apophysis wider than the urn when moist, but narrower when dry. The apophysis is also distinctly roughened to corrugate. A common species of sandy loam soils and disturbed habitats in urban areas.

The type specimen was collected by L. Preiss in 1839 from York, Western Australia.

Represented by 16 collections from the study area.

**Gemmabryum preissianum** (Hampe) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 67 (2005).

*Brachymenium preissianum* (Hampe) A.Jaeger, *Ber. Thätigkeit. St. Gallischen Naturwiss. Ges.* 1873–74: 113 (*Gen. Sp. Musc.* 1: 575) (1875).

Plants are short and form dense green to yellowish green tufts. Spence and Ramsay (2006) give the small, lanceolate to ovate-lanceolate leaves that are up to 1 mm in length with a short stout hairpoint,



and the narrow-mouthed, inclined to horizontal capsules with a rostellate operculum as characteristic of the species.

The type specimen was collected in 1823 by L. Preiss in Fremantle, Western Australia.

Represented by 6 collections from the study area.

**Gemmabryum sullivanii** (Müll.Hal.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 68 (2005).

*Bryum sullivanii* Müll.Hal., *Oefvers. Förh. Finska Vetensk.-Soc.* 35: 48 (1893).

Stated by Spence and Ramsay (2006) to be a rare species found mainly on damp soil or rock in or near streams and often on limestone. The stems are short, only to about 3 mm tall. The plants are green to brownish green or blackish and glossy when moist, the leaves ovate, concave, weakly costate, and evenly distributed along the stems. This species is endemic to Australia.

Represented by three collections from the study area.

**Ptychostomum angustifolium** (Brid.) J.R.Spence & H.P.Ramsay, *Phytologia* 87: 23 (2005).

*Bryum caespiticium* Hedw., *Sp. Musc. Frond.* 180 (1801), *vide* J.R.Spence, *Phytologia* 87: 23 (2005).

The plants form dense, comose tufts up to 2 cm tall, pale bright green above and brownish below. Spence and Ramsay (2006) give the elongate, thin-walled laminal cells, absence of a distinct leaf border and long excurrent hairpoint as diagnostic features. It is dioicous, having separate male and female plants. The majority of collections have come from disturbed sites, such as charcoal and burnt soil, between paving stones and along garden paths.

Represented by ten collections from the study area.

**Rosulabryum albolimbatum** (Hampe) J.R.Spence, *Bryologist* 99: 223 (1996).

*Bryum albolimbatum* (Hampe) A.Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1873–74: 191 (*Gen. Sp. Musc.* 1: 653) (1875).

The genus *Rosulabryum* J.R.Spence is characterised by the plants having the leaves enlarged and crowded at the stem apex, resembling a rosette. The leaves are generally oblong-ovate with serrate margins and the plants often have rhizoidal tubers.

The plants form loose, deep green to reddish green tufts. The leaves are up to 3.5 mm long with the upper margins coarsely serrate. Filamentous gemmae are often found in the leaf axils and the rhizoidal tubers are orange, rounded to ovoid and 250–400 µm in diameter.

Ochi (1970) considered this species a synonym of *Bryum* (*Rosulabryum*) *capillare* Hedw., but later (Syed 1973) *R. albolimbatum* was recognised as a distinct species. It is a widespread Australian endemic species, occurring on soil or, more commonly, in moist and shaded habitats on wood or rock (Spence & Ramsay 2006).

The type specimen was collected by F. Mueller from the Porongorups in 1867.

Represented by eight collections from the study area.

**Rosulabryum billarderi** (Schwägr.) J.R.Spence, *Bryologist* 99: 223 (1996), as ‘billardierei’.

*Bryum billarderi* Schwägr., *Sp. Musc. Frond.*, Suppl. 2: 115. pl. 76. (1816).

A widespread species growing on soil, soil over rock, or on wood. The plants form loose to dense, green to yellowish green tufts. The leaves are up to 5 mm long, with the margin distinctly toothed in the upper part, recurved towards the base and with a narrow border 1–3 cells wide. Rhizoidal tubers are red to orange, rounded to ovoid and up to 1 mm in diameter. It is a variable species and has been comprehensively revised by Haji Mohamed (1979).

Represented by 20 collections from the study area.

**Rosulabryum campylothecium** (Taylor) J.R.Spence, *Bryologist* 99: 223 (1996).

*Bryum campylothecium* Taylor, *London J. Bot.* 5: 52 (1846).

Forms yellowish green to brownish green, loose to dense tufts. The leaves have small, blunt teeth along the upper margins and the margins are recurved at the base. The marginal border is 2–4 cells wide. The costa is excurrent as a long hairpoint. Neither rhizoidal tubers nor axillary gemmae are known for the species. Spence and Ramsay (2006) state that the golden or yellow-green colour of the plants, the leaves that are ovate, concave and imbricate, and the absence of tubers are characteristic.

The type specimen was collected by J. Drummond in 1843 from ‘Swan River’, Western Australia.

Represented by 11 collections from the study area.

**Rosulabryum capillare** (Hedw.) J.R.Spence, *Bryologist* 99: 223 (1996).

*Bryum capillare* Hedw., *Sp. Musc. Frond.* 182 (1801).

The plants form loose to dense, dark green tufts. When dry the leaves are spirally twisted around the stems. The leaves are up to 3 mm long, the upper margins finely serrulate, and the costa is percurrent to shortly excurrent. Reddish brown, globular to ovoid rhizoidal tubers 60–250 µm in diameter are produced.

Represented by one collection from the study area.

**Rosulabryum torquescens** (Bruch ex De Not.) J.R.Spence, *Bryologist* 99: 223 (1996).

*Bryum torquescens* Bruch ex De Not., *Syllab. Musc.* 163 (1838).

A common species of drier habitats. Plants form loose to dense, green to reddish green tufts. The leaves are contorted but not spirally twisted around the stems when dry. The leaf margins are toothed,

recurved, and have a strong border. Red or sometimes orange, rounded rhizoidal gemmae to 250 µm are produced.

Represented by 11 collections from the study area.

## Dicranaceae

La Farge *et al.* (2000) have suggested that the genus *Campylopus* Brid. was better placed within Leucobryaceae, based on molecular genetic analysis. This transfer was adopted by Streimann and Klazenga (2002) and in McCarthy (2006). However, the transfer has not been generally accepted and is not followed by the TROPICOS database [<http://mobot.mobot.org/W3T/Search/most.html>]. Until further evaluation and general acceptance of the transfer, the genus *Campylopus* is here retained within Dicranaceae.

### **Campylopus australis** Catches. & J.-P.Frahm, *J. Bryol.* 13: 360 (1985).

Catcheside and Frahm (1985) stated that this species had been found in dry sclerophyll forest having >250 mm annual rainfall. The alar cells of the leaves form a prominent auricle with the marginal cells narrower and hyaline. Above the alar cells the basal laminal cells are incrassate and coloured, rectangular adjacent to the costa and grading quickly to rectangular cells that become narrow and thin-walled near the margin. The costa occupies approximately 40% of the width of the basal part of the leaf.

Represented by nine collections from the study area.

### **Campylopus bicolor** (Hornsch. ex Müll.Hal.) Wilson var. **bicolor**, *Fl. Nov. Zel.* 2: 69 (1854).

A species found primarily in moist habitats, e.g. in seepage channels over rock. Forms dense, dark green to dark yellowish brown tufts on wet ground or on rock. The leaves are 4–5 mm long, crowded, erect to sub-erect, concave and ovate-lanceolate, with the apex lacking a hairpoint. The costa is broad throughout the leaf, occupying 1/2–3/4 the width of the leaf base.

Represented by 17 collections from the study area.

### **Campylopus flindersii** Catches. & J.-P.Frahm, *J. Bryol.* 13: 363, f. 3 (1985).

The plants form small green tufts with the shoots and leaves often slightly curved. The leaves are lanceolate, up to 2.5 mm long and erect-spreading when moist. The costa occupies about 2/3 of the width of the leaf base. Basal cells of the leaf are thin-walled but do not form a defined alar group. This species has not been collected fertile, although vegetative reproduction by deciduous shoot apices is common. The species is described and illustrated by Catcheside and Frahm (1985).

Represented by three collections from the study area.

### **Campylopus introflexus** (Hedw.) Brid., *Muscol. Recent Suppl.* 4: 72 (1819 [1818]).

In its typical form, with the hyaline leafpoints reflexed outwards at right angles to the leaf, the species is readily recognisable. The leaves sometimes have the hyaline points more or less erect.

The plants form dense, golden green to light green tufts or turfs. The stems are sometimes blackish below. The leaves are 4–6 mm long, from an oblong to ovate-lanceolate, concave base, gradually tapering to a long and narrow subula ending in a roughened hyaline hairpoint. The costa is up to 3/4 the width of the leaf at the base and excurrent into the hyaline hairpoint which is reflexed. The costa has numerous parallel ridges 1 or 2 cells high on its abaxial surface, best seen in transverse section. The alar cells at the basal marginal angles of the leaves are hyaline or pale brown, but not inflated.

Represented by 111 collections from the study area.

**Dicranoloma diaphanoneuron** (Hampe & Müll.Hal.) Paris, *Index Bryol.* 2: 26 (1904).

The genus *Dicranoloma* Renault (Renauld) in Australia was recently monographed by Klazenga (2003).

The species occurs on rocks, logs, tree stumps and tree stems. The plants form short, densely foliose, yellowish brown turfs. Leaves are up to 5 mm long, slender, little more than 0.5 mm wide, with an ovate-elongate base that tapers to a long, slender, channelled and irregularly falcate-secund subula. The costa is narrow and ceases in, or shortly beyond, the apex of the leaf.

The type collection of *D. diaphanoneuron* was made by F. Mueller from the Stirling Range and it is primarily a species of south-west Western Australia. Outside Western Australia, the species is known from single collections in Tasmania and Victoria. Catcheside (1980) reported it as rare in South Australia.

Represented by four collections from the study area.

## Ditrichaceae

**Ceratodon purpureus** (Hedw.) Brid. subsp. **convolutus** (Reichardt) Burley, *Harvard Pap. Bot.* 2: 57 (1990).

*Ceratodon purpureus* is one of the most widespread and common mosses in the Perth Region. Because it is a common species of disturbed habitats, it is often not collected. There is considerable variation in morphology throughout its range. Often forms extensive patches as a colonist of disturbed ground. When fruiting, the purple setae and longitudinally grooved, cylindrical, inclined to nodding capsules are particularly striking.

Represented by 12 collections from the study area.

**Ditrichum difficile** (Duby) M.Fleisch., *Musc. Buitenzorg* 1: 300 (1904).

Plants are gregarious, forming loose to closely packed, yellowish to dark green patches. Leaves are long and flexuose, wide-spreading from a sheathing base that tapers gradually to a long and channelled subula. The capsules are asymmetric, slightly curved, and flattened when empty.

In Australia the species is distributed widely in the Eastern States, with outlying populations in South Australia and in south-west Western Australia (Seppelt 1982). A rather variable species in its gross morphology, particularly in capsule length.

Represented by four collections from the study area.

***Eccremidium arcuatum*** (Hook.f. & Wilson) Müll.Hal., *Syn. Musc. Frond.* 1: 425 (1848).

*Eccremidium* Wilson is a small genus of seven species of very small mosses, six of which are found in Australia. The stems are mostly only a few millimeters tall and simple or with few branches. Spores are very large, from 60–100 µm in diameter. *Eccremidium arcuatum* and *E. pulchellum* (Hook.f. & Wilson) Müll.Hal. have julaceous stems, with the leaves short, ovoid and overlapping.

Plants of *E. arcuatum* are greenish gold above and reddish gold below. The leaves are less than 1 mm long and arranged in more or less three rows on the stems. The margins of the leaf have a characteristic serrulation, with the marginal cells extended into curled, finger-like projections (Scott & Stone 1976). When fruiting, the perichaetial leaves are considerably longer than the normal stem leaves and are usually curved to one side of the stem.

Represented by two collections from the study area.

***Eccremidium exiguum*** (Hook.f. & Wilson) Wilson, *Rev. Bryol.* 27: 85 (1900).

The stems of this species are very short, the entire plant being only about 1 mm tall. Usually, several branches arise from the stem base, resulting in the stems appearing clustered. The leaves are mostly ovate-lanceolate, narrowing to a long subula that is filled by the costa.

Represented by one collection from the study area.

***Eccremidium minutum*** (Mitt.) I.G.Stone & G.A.M.Scott, *J. Bryol.* 7: 603 (1973 [1974]).

The stems are very short, less than 1 mm tall and the leaves are up to 2 mm long, tapering to a relatively broad apex about 1/5 the width of the leaf. The leaf margins are often conspicuously serrate and the costa obscure.

Represented by one collection from the study area.

***Eccremidium pulchellum*** (Hook.f. & Wilson) Müll.Hal., *Syn. Musc. Frond.* 1: 425 (1848).

Like *E. arcuatum*, this species has julaceous stems. The leaves are broadly ovate, apiculate and the margins are entire to serrate. Unlike *E. arcuatum*, the leaf margins appear serrulate by collapse or erosion of the outer cell wall (Scott & Stone 1976).

Represented by 17 collections from the study area.

**Pleuridium ecklonii** (Hampe ex Mitt.) Snider, *J. Hattori Bot. Lab.* 39: 155 (1975).

*Archidium ecklonii* Hampe ex Mitt., *J. Linn. Soc., Bot.* 22: 299 (1886), *non* Hampe ex Müll.Hal. *Hedwigia* 38: 53 (1899).

In his revision of *Archidium*, Snider (1975) excluded *A. ecklonii* from the genus and referred it to *Pleuridium* Brid. on the basis of leaf morphology and perichaetial leaves. The plants are small, up to 1 cm tall, slender, and form tufts on soil. The leaves are distant, small, up to 1 mm long, ovate-acuminate, with a percurrent costa, and held erect and close to the stems. Magill (1981) suggested that in the absence of fertile material the generic placement remained equivocal.

Represented by 17 collections from the study area.

**Pleuridium nervosum** (Hook.) Mitt. var. **nervosum**, *Hooker's J. Bot. Kew Gard. Misc.* 8: 257 (1856).

Stems of the plants are short, 2–5 mm tall, and tend to form dense turfs. The lower parts of the stems are julaceous. The leaves are short, 0.5–1 mm long, closely imbricate, increasing in length up the stems and becoming ovate-lanceolate. Perichaetial leaves are larger, 2–3 mm long and lanceolate-subulate. Often entirely julaceous, unbranched vegetative shoots are encountered. These are slender, barely 0.5 mm in diameter, and mostly yellowish green.

Represented by two collections from the study area.

## Fabroniaceae

**Fabronia hampeana** Sond., *Hampe, Icon. Musc.* 13 (1844).

*Fabronia incana* Taylor, *London J. Bot.* 5: 58 (1846), *fide* Wijk *et al.* *Index Musc.* 2 (D - Hypno). *Regnum Veg.* 26: 535 (1962).

*Fabronia tomentosa* Hook.f. & Wilson, *Icon. Pl.* 6: pl. 739a (1845), *fide* Wijk *et al.* *Index Musc.* 2 (D - Hypno). *Regnum Veg.* 26: 535 (1962).

This is a highly distinctive moss, endemic to Western Australia, and easily recognized by its silvery green, imbricate, linear-lanceolate leaves that have numerous, long, single-celled cilia along the margins.

The type specimen was collected from near Perth on a trunk of *Macrozamia preissii* Lehm. The type specimens of *F. incana* and *F. tomentosa* were both collected by J. Drummond from 'Swan River'.

Represented by three collections from the study area.

## Fissidentaceae

A family easily recognised by the leaves being in two rows along the stem, and the unique structure of the leaves, being Y-shaped in transverse section, with two vaginant laminae clasping the stem and a single dorsal lamina.

**Fissidens bifrons** Schimp. ex Müll.Hal., *Bot. Zeitung (Berlin)* 17: 198 (1859).

Plants grow on soil and are yellowish green, small, with the stems to only 3–4 mm in length, occasionally longer. The leaves are characteristically curved and asymmetric on sterile shoots and unbordered, except in the largest leaves where the vaginant laminae, which extend to more than 3/4 leaf length, are bordered. The seta is flexuose, up to 2 cm long, the capsule curved and asymmetric and barely 1 mm in length.

Catcheside (1980) listed this species as a synonym under *F. splachnifolius* Hornsch. and Magill (1981) considered *F. bifrons* a synonym of *F. pygmaeus* Hornsch. However, Stone (1994), after examining type specimens, preferred to retain all three as distinct species.

Represented by two collections from the study area.

**Fissidens curvatus** Hornsch. var. **curvatus**, *Linnaea* 15: 148 (1841).

*Fissidens pungens* Hampe & Müll.Hal., *Linnaea* 26: 502 (1855).

Plants grow on soil and are small, to about 5 mm long, scattered, yellow-green to dark green and glossy. The leaves are larger in the upper part of the stems, to about 1 mm long, slightly contorted when dry, erect-spreading when moist. The leaf apex is acute to acuminate, the margins entire and strongly bordered throughout, with the border of several cell layers. The vaginant lamina reaches to about 2/3 of the leaf length. Sporophytes are terminal, with the seta to about 1 cm long, the capsules 0.5–1 mm long, erect and symmetric to horizontal and arcuate (Magill 1981; Beever *et al.* 2002).

Represented by one collection from the study area.

**Fissidens leptocladus** Müll.Hal. ex Rodway, *Pap. Proc. R. Soc. Tasmania* 1912: 136 (1913).

Plants grow on rock or soil with a preference for calcareous substrates. Stems are densely aggregated, to 10 mm or slightly longer, yellow-green to dark green. Leaves are crisped when dry, often undulate and falcate when moist, linear-lanceolate to lanceolate or oblong-ovate, with an acute apex. The vaginant lamina reaches to about 2/3 of the leaf length. Leaf margins are serrulate towards the apex, entire below and with a unistratose to bistratose border that fails shortly below the apex. Sporophytes are terminal on the stems with the seta short, to about 4 mm long, and the capsules inclined, asymmetric and up to 1 mm long (Beever *et al.* 2002).

Represented by two collections from the study area.

**Fissidens megalotis** Schimp. ex Müll.Hal., *Bot. Zeitung (Berlin)* 16: 154 (1858).

*Fissidens vittatus* Hook. & Wilson, *Fl. Tasman.* 2: 167, 171, f. 6 (1859), *vide* Bruggeman-Nannenga & Pursell, *Lindbergia* 20: 51 (1995 [1996]).

Plants grow on soil or rock in exposed sites in dense, yellowish green to brownish green patches. The shoots are rolled up when dry. When moist the leaves are spreading to squarrose-recurved, falcate-secund, oblong, to about 1.5 mm long, with an obtuse and apiculate apex. The vaginant laminae extend to 2/3–3/4 of the leaf length. The leaf margins are irregularly serrulate at the apex, elsewhere entire, and with a bistratose border that is conspicuous on the vaginant laminae but inconspicuous on the dorsal and apical laminae. The upper and dorsal lamina cells are smooth to weakly multipapillose (Beever *et al.* 2002).

Represented by nine collections from the study area.

**Fissidens taylorii** Müll.Hal. var. **taylorii**, *Syn. Musc. Frond.* 1: 65 (1848).

Plants mostly form yellow-green to green gregarious patches or small groups on damp soil. The stems are up to 8 mm tall, with erect-spreading leaves that are little altered when wet or dry. The leaves are oblong to lanceolate, to about 0.8 mm long. The vaginant laminae reach from 2/3–4/5 of the leaf length. Leaf margins are entire to minutely serrulate, without a border except on the vaginant laminae where the border may be very weak. Sporophytes are terminal on the shoots, the seta to about 5 mm long, the capsule erect to inclined and symmetrical (Catcheside 1980; Beever *et al.* 2002).

Represented by 11 collections from the study area.

**Fissidens tenellus** Hook.f. & Wilson var. **tenellus**, *Fl. Nov. Zel.* 2: 62. pl. 83: f. 6 (1854).

Plants form yellowish green to dark green, loose to dense patches. The stems are short, to about 3 mm long. The leaves are spreading, little altered wet or dry, linear-lanceolate with an acute to acuminate apex and about 1 mm long. The vaginant laminae extend to about 1/2 of the leaf length. The margins are crenulate on both dorsal and apical laminae, irregularly dentate on the vaginant laminae. Lamina cells of the apical and dorsal laminae are weakly to strongly unipapillose. Sporophytes are terminal on the shoot, the seta up to 10 mm long, the capsules erect, symmetric and 0.5–0.7 mm long (Catcheside 1980; Beever *et al.* 2002).

Represented by six collections from the study area.

## Funariaceae

The family Funariaceae was revised for Australia by Fife and Seppelt (2001). A family of considerable gametophytic similarity, most genera and species are distinguished primarily on features of the sporophyte.

**Entosthodon apophysatus** (Taylor) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 80 (1859).

*Funaria apophysata* (Taylor) Broth., *Nat. Pflanzenfam.* 1(3): 523, 379 (1903).



Plants are yellowish green with reddish brown stems to about 5 mm tall. The capsules are erect or rarely inclined, symmetric, oblong-cylindric, 3–4.5 mm long, with a well-differentiated and tapering neck about 1/2 the capsule length, and borne on a seta 2–4 mm long. The capsule mouth is about 2/3 the width of the capsule and there is no peristome. Fife and Seppelt (2001) noted that the long, oblong-cylindric capsules without a peristome, short setae, and the comal leaves with a strong bristle-like hairpoint are distinctive features of this species.

The lectotype specimen of *Physcomitrium apophysatum* (Taylor) Wilson (syn. *Funaria apophysata* (Taylor) Broth.), was collected in 1843 by J. Drummond from 'Swan River'.

Represented by one collection from the study area.

**Entosthodon productus** Mitt., *Fl. Tasman.* 2: 197 (1859).

*Funaria producta* (Mitt.) Broth., *Nat. Pflanzenfam.* 1(3): 522 (1903).

Plants are yellowish green with reddish brown stems to about 4 mm long. The capsules are erect, symmetric and oblong-pyriform in shape, to about 1 mm long or slightly longer, gradually tapered with an irregularly wrinkled neck about 1/2 the capsule length. There is no peristome. The seta is short and less than 10 mm long (Fife & Seppelt 2001).

Represented by one collection from the study area.

**Entosthodon subnudus** (Taylor) Fife var. **gracilis** (Hook.f. & Wilson) Fife, *J. Hattori Bot. Lab.* 58: 192 (1985).

A species typically of fine clay or silty soils (Fife and Seppelt 2001), plants are yellowish green to brownish green, the stems reddish brown and short, to about 5 mm tall. Capsules are symmetric, obovoid to obovoid-cylindric, 1.5–2 mm long, strongly constricted below the mouth when dry, and with the mouth the same diameter as the capsule. The peristome is double. The seta reaches to about 2 cm long.

Represented by one collection from the study area.

**Funaria hygrometrica** Hedw., *Sp. Musc. Frond.* 172 (1801).

A common colonist species, particularly of recently burnt ground, flower pots in plant nurseries, roadsides etc. Plants form yellowish green to green patches or occur as scattered plants on disturbed ground, especially burnt sites, on burnt wood, old walls etc. Leaves are up to 4 mm long by 1 mm wide, widest above the middle. Stems may be up to 3 cm long but are usually much shorter. Most distinctive when fruiting, the setae are up to 4 cm long, arcuate and flexuose. Capsules are up to 3 mm long, 1 mm wide, pyriform, asymmetric with an oblique, red-rimmed mouth about 0.8 mm in diameter. The capsules are striate when moist, longitudinally grooved when dry and empty. There is a double peristome, with the outer ring of teeth joined to a central disc at their tip (Fife & Seppelt 2001).

Represented by 26 collections from the study area.

## Gigaspermaceae

**Gigaspermum repens** (Hook.) Lindb., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad.* 21: 599 (1865).

Stone (2006) commented that the species was once common along undisturbed roadsides but that its abundance has been greatly reduced by weed growth and the use of fertilizers. The small, pale yellowish green shoots are often tightly clustered together and arise from a branched subterranean rhizome (Herrnstadt *et al.* 1980; Stone 2006a). This species produces abundant capsules. When fruiting the immersed capsules are globose to urn-shaped, wide-mouthed, and the brown spores are large for mosses (100–150 µm).

The type specimen was collected by L. Preiss in 1839 from ‘Swan River’, Western Australia.

Represented by two collections from the study area.

## Grimmiaceae

**Grimmia laevigata** (Brid.) Brid., *Bryol. Univ.* 1: 183 (1826).

*Grimmia leiocarpa* Taylor, *London J. Bot.* 5: 44 (1846).

Plants form loose, dark green tufts with long, hyaline leaf apices giving the tufts a distinctly hoary appearance. Leaves are up to 2 mm long, crowded on the stems, triangular to oblong-lanceolate with a broad base, concave above and abruptly narrowed to a long, hyaline, sharply denticulate hairpoint. In transverse section the leaves are bistratose except at their base. The capsules are erect, about 1 mm long, ovoid to oblong-cylindric and smooth. Characteristic of *G. laevigata* are the erect-spreading, concave-triangular leaves and clearly denticulate hairpoints. Nearly the entire leaf lamina is bistratose and the basal marginal cells are wider than long (Greven 2003).

The type collection of *G. leiocarpa* was made by J. Drummond from ‘Swan River’.

Represented by nine collections from the study area.

**Grimmia pulvinata** (Hedw.) Sm. var. **africana** (Hedw.) Hook.f. & Wilson, *Fl. Nov. Zel.* 2: 75 (1854).

Plants form light to dark green, usually hemispherical, hoary cushions. The lanceolate leaves are abruptly contracted into a short to long, smooth to denticulate hairpoint. The leaf margins are recurved from the apex to near the base. In transverse section the leaves are unistratose except for a bistratose margin towards the apex. The capsules are 1–1.5 mm long, with an obliquely rostellate operculum. The species is easily recognized by its neat, rounded cushions with abundant oblong-ovoid and striate capsules (Greven 2003).

Represented by two collections from the study area.

## Hedwigiaceae

### **Hedwigia ciliata** (Hedw.) P.Beauv., *Prodr. Aethéogam.* 15 (1805).

Plants form loose, yellowish green to whitish green mats with procumbent stems on rock. Leaves are ovate to ovate-lanceolate, concave, and up to 2 mm long, closely imbricate, erect and with reflexed tips when dry, spreading when moist. Leaf margins are revolute towards the base. The leaf apex is acuminate, hyaline and dentate. There is no costa. Capsules lack a peristome, are 1–1.5 mm long, subglobose with a red rim and borne on a very short seta. Mid to upper lamina cells are oblong, incrassate, thick-walled and have a single papilla over the centre of the cell on both surfaces. Basal cells are elongate and have a single row of papillae.

Represented by one collection from the study area.

### **Hedwigidium integrifolium** (P.Beauv.) Dixon, *Skand. Bladmossfl.* 369 (1939).

Plants form loose, procumbent, green to yellowish brown mats on rock. The leaves are up to 1.75 mm long, broadly ovate-lanceolate, shortly acuminate to apiculate, spreading when moist, erect and closely imbricate when dry. The leaf margins are revolute from the base to near the apex and there is no costa. Upper lamina cells are thick-walled, oblong, incrassate, with several simple papillae. The basal lamina cells are elongate and have a single row of papillae. The capsules are broadly ovoid, to 1.5 mm long, and immersed on a short seta.

Represented by three collections from the study area.

## Meesiaceae

### **Leptobryum pyriforme** (Hedw.) Wilson, *Bryol. Brit.* 219 (1855).

A cosmopolitan annual species that is commonly found in disturbed sites. Together with *Funaria hygrometrica* and the liverwort genus *Marchantia*, it is common on flower pots in plant nurseries. The narrow, lanceolate-subulate leaves with a short, sheathing base are 2–5 mm long and arranged in comal tufts at the stem apices. The 1.5–2.5 mm long, pyriform capsule, borne on a slender 1–3 cm long seta, is characteristic.

Represented by four collections from the study area.

## Mniaceae

### **Pohlia nutans** (Hedw.) Lindb., *Musci Scand.* 18 (1879).

Vegetatively, *Pohlia* Hedw. is easily confused with *Bryum* Hedw. *sens. lat.* The lamina cells of *Pohlia* are narrow-rectangular to narrow-rhomboidal and the leaves unbordered. Lamina cells of *Bryum* are commonly rhomboid to hexagonal in shape.

Leaves of *P. nutans* are green to yellow-green, ovate to narrowly-lanceolate, 1.5–2.0 mm long, with an orange-brown costa and decurrent leaf basal angles. Leaves are smaller in the basal part of stems and clustered together in a ± comal tuft at the stem tip.

Represented by two collections from the study area.

**Schizyemenium bryoides** Harv., *Icon. Pl.* 3: pl. 202 (1840).

*Mielichhoferia bryoides* (Harv.) Wijk & Margad., *Taxon* 11: 221 (1962).

The stems are short, to about 1 cm tall and reddish—which may lead to confusion with *Pohlia*—and the leaves, to 1.5 mm long, somewhat pale green and shiny. Antheridia and archegonia occur on short basal branches, whereas in *Pohlia* they are terminal on the main stems.

Represented by one collection from the study area, from damp soil.

### Orthodontiaceae

**Orthodontium lineare** Schwägr., *Sp. Musc. Frond. Suppl.* 2(2): 188 (1827).

Plants occur on rotting wood or bark or burnt wood and are small, the stems to only about 5 mm long, with long and narrow, yellowish green leaves to about 4 mm in length. The leaves are flat and ribbon-like, tapering gradually from the base to a somewhat blunt apex. Lamina cells are long and narrow-rhomboid, becoming longer and wider towards the base. The capsules are 2–2.5 mm long, cylindrical, and usually grooved when dry and mature.

The type specimen was collected in Western Australia by J. Drummond.

Represented by one collection from the study area.

### Orthotrichaceae

**Zygodon menziesii** (Schwägr.) Arn., *Mem. Soc. Linn. Paris* 5: 233 (1827).

*Zygodon drummondii* Taylor, *London J. Bot.* 5: 46 (1846).

In the study area the species has been collected on bark and from sand over limestone. The plants are up to 1 cm tall and form very dense tufts that are olive-green to dark green above and brown to reddish brown below. The leaves are up to 2 mm long, lanceolate to ovate-lanceolate, the margins recurved and the costa ceases shortly below the apex. Axillary, green to brownish, 4–8 celled asexual propagules are often found on non-fruiting plants. The leaf cells are smooth.

The type collection of *Z. drummondii* was made by J. Drummond from ‘Swan River’. Lewinsky (1990) synonymised *Z. drummondii* under *Z. menziesii*.

Represented by eight collections from the study area.

## Pottiaceae

The family Pottiaceae, so characteristic of dry climates, is well represented in the Perth region and in other parts of the State. Zander (1993) provided an extensive monographic revision of the family. Typically, the leaf lamina cells are papillose, but some species may lack papillae.

**Barbula calycina** Schwägr., *Sp. Musc. Frond. Suppl.* 1: 63, pl. 119 (1823).

*Tortella calycina* (Schwägr.) Dixon, *Bull. New Zealand Inst.* 3(3): 124 (1924).

Forms green to yellowish brown tufts on soil, wood, or rock. This is a rather variable species. Stems are up to 3 cm high, simple or occasionally branched. The leaves are up to 3 mm long, oblong-lanceolate, appressed and contorted when dry, erect-spreading when moist, and variably undulate. The costa is excurrent into a hairpoint of variable length. Upper lamina cells are densely papillose, isodiametric, becoming longer and elongate, hyaline and smooth in the leaf base. Axillary hairs are very long, the basal cells brownish and the upper 8–10 cells hyaline. Perichaetial leaves have a long sheathing base. The capsules are slightly inclined, asymmetric, to about 2 mm in length. The peristome is long, often longer than the capsule, arises from a basal membrane and is composed of 32 long, papillose filaments that are twisted around approximately twice.

Represented by 75 collections from the study area.

**Barbula hornschurchiana** Schultz, *Syll. Pl. Nov.* 1: 35 (1824 [1822]).

Plants are small, with the stems reaching up to 1 cm tall, forming dense turfs that are olive-green to brownish green when dry and green when moist. The leaves are narrowly triangular, curled and twisted around the stems when dry, spreading to reflexed when moist. The leaf margins are strongly revolute from the base to the apex. There is a strong costa that is excurrent into a short, bristle-like point.

Represented by four collections from the study area.

**Barbula indica** (Hook.) Spreng., *Nomencl. Bot.* 2: 72 (1824).

Plants form loose light green tufts on soil. Stems are up to 8 mm long. The leaves are crisped when dry, spreading when wet, lanceolate to ovate-lingulate, to about 1.8 mm long, with an obtuse and apiculate apex. The margins are plane to infrequently recurved below and entire. The costa is shortly excurrent. Upper lamina cells are quadrate, with 3 or 4 large, C-shaped papillae over the lumen; basal cells are oblong, elongate, hyaline and smooth. Multicellular, brownish, obovoid gemmae are produced in the leaf axils or on axillary rhizoids (Magill 1981).

Represented by one collection from the study area.

**Bryoerythrophyllum binnsii** (R.Br.) Wijk & Margad., *Taxon* 8: 71 (1959).

*Bryoerythrophyllum jamesonii* (Taylor) H.A.Crum, *Svensk Bot. Tidskr.* 51: 200 (1957).

Plants form yellowish green to reddish brown tufts on earth or rock. The stems are up to 1 cm tall. Leaves are 1.5–2.5 mm long, oblong-lanceolate, acute, with a hyaline point. Upper lamina cells are subquadrate and papillose, becoming rectangular and hyaline at the base.

Represented by three collections from the study area.

**Didymodon australasiae** (Hook. & Grev.) R.H.Zander, *Phytologia* 41: 21 (1978).

*Trichostomopsis australasiae* (Hook. & Grev.) H.Rob., *Phytologia* 20: 187 (1970).

Forms loose tufts with the stems to about 1 cm high. The leaves are crowded, incurved or twisted when dry, spreading when moist, to about 2.5 mm long, oblong to narrowly-lanceolate,  $\pm$  channelled towards the acute apex. Upper lamina cells are subquadrate to  $\pm$  isodiametric with numerous papillae. Cells at the base of the leaf are elongate-rectangular, with a few marginal rows slightly narrower. Axillary hairs consist of about 4 cells with only the basal cell short and brownish. Capsules are oblong-ellipsoid and up to 2 mm long. The peristome is relatively short, less than 1/4 the length of the capsule and not twisted.

Represented by 11 collections from the study area.

**Didymodon torquatus** (Taylor) Catches., *Mosses S. Australia* 174 (1980).

*Barbula torquata* Taylor, *London J. Bot.* 5: 50 (1846).

A common species of soil in drier habitats. Stems to 1 cm tall. Leaves 1–2.5 mm long, spirally twisted around the stem when dry, spreading when moist, broadly lanceolate and acuminate, the margins closely recurved. The costa is percurrent or shortly excurrent. Upper lamina cells are subquadrate and papillose; basal cells are short rectangular, firm-walled.

The type collection of *B. torquata* was made by J. Drummond from 'Swan River'.

Represented by 12 collections from the study area.

**Gymnostomum calcareum** Nees & Hornsch., *Bryol. Germ.* 1: 153, pl. 10, f. 15 (1823).

Plants form dense, bright green tufts, primarily on calcareous substrates. Stems are up to 2 cm tall. Leaves are to 1 mm long, slightly twisted when dry, erect-spreading when moist, narrowly lingulate to linear, the apex mostly rounded-obtuse. Lamina cells are subquadrate to quadrate and papillose on both surfaces; basal lamina cells are rectangular and smooth. Capsules are usually numerous, to 1 mm long, elliptic-oblong to cylindrical, orange-yellow with a reddish mouth, and lack a peristome.

Represented by six collections from the study area.

**Leptodontium paradoxum** I.G.Stone & G.A.M.Scott, *J. Bryol.* 11: 701, f. 1–2a–d, pl. 1 (1981 [1982]).

Plants form loose, green to yellow-brown mats on soil. The stems are densely leaved, particularly in the upper parts. Leaves are slightly falcate-secund, up to 3.5 mm long and 1.0 mm wide, ovate-lanceolate to lanceolate, with a loosely sheathing base up to half the leaf length. Upper lamina cells are 6–11  $\mu$ m, rounded, quadrate or sometimes short-rectangular, with 4–6 mostly simple papillae per cell. Cells of the leaf base are rectangular, with one to several marginal rows short and rectangular

to quadrate. Axillary hairs are long-filamentous and consist of 9–15 hyaline cells and 2 or 3 short, sometimes pale brown, basal cells (Stone & Scott 1981).

Represented by one collection from the study area.

**Syntrichia antarctica** (Hampe) R.H.Zander, *Bull. Buffalo Soc. Nat. Sci.* 32: 267 (1993).

*Tortula antarctica* (Hampe) Wilson, *Fl. Tasm.* 2: 175, 172, f. 8 (1859).

Plants form loose, green tufts commonly on dry soils. Stems are up to 2 cm long. Leaves have a distinct red-brown costa with a toothed hairpoint. When dry the leaves become twisted but spread wide when moist. Cells are rectangular and densely papillose.

Represented by 11 collections from the study area.

**Syntrichia pagorum** (Milde) J.J.Amann, *Fl. Mousses Suisse* 2: 117 (1918).

*Tortula pagorum* (Milde) De Not., *Atti Univ. Genova* 1: 542 (1869), *vide* R.H.Zander, *Bull. Buffalo Soc. Nat. Sci.* 32: 334 (1993).

Plants form dense, green tufts or mats on trees or shrubs. The stems are up to 5 mm long. Leaves occur mostly in a terminal rosette and are incurved and appressed when dry, spreading when moist, lingulate, concave, to 2.5 mm long, 1 mm wide, with a rounded-truncate apex. The costa is reddish and excurrent into a smooth hairpoint up to 1 mm long. Upper lamina cells are quadrate, papillose, those at the base rectangular and hyaline. Small, lanceolate to elliptic, leaf-like, densely papillose propagules are produced in the axils of upper leaves.

The type specimen was collected in 1839 by L. Preiss from Rottneest Island, Western Australia.

Represented by 22 collections from the study area, all from the bark or trunks of trees.

**Syntrichia papillosa** (Wilson) Jur., *Laubm.-Fl. Oestr.-Ung.* 141 (1882).

*Tortula papillosa* Wilson, *London J. Bot.* 4: 193 (1845).

Plants form small, dark green to greenish brown tufts on bark. The stems are up to 5 mm long. Leaves are up to 3 mm long, crowded, broadly oblong-spathulate to obovate-spathulate, concave, with a rounded, obtuse apex, the margins involute towards the apex. The costa is excurrent into a hyaline, bristle-like point of variable length. Multicellular, broadly oval or rounded gemmae are borne on the adaxial surface of the costa towards the distal part of the leaf.

Represented by four collections from the study area.

**Tetrapterum cylindricum** (Taylor) A.Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1868–69: 86 (1869).

The stems are up to 2 cm tall. Leaves are lanceolate, to 1.5 mm long, erect to erecto-patent,

with a broader, hyaline base. When dry the leaves are folded along the costa, incurved and spirally twisted around the stems. The costa is strong and shortly excurrent. Upper lamina cells are irregularly hexagonal and papillose; basal lamina cells are short-rectangular with firm walls. The capsule is oblong to cylindrical, 1–1.4 mm long, emergent from the perichaetial leaves, and the seta is short, about 1–2 mm long.

Represented by two collections from the study area.

**Tortella rubripes** (Mitt.) Broth., *Nat. Pflanzenfam.* 1(3): 397 (1902).

*Trichostomum rubripes* Mitt., *Handbook of the New Zealand Flora* 417 (1867).

An apparently coastal-maritime species. Plants form dense tufts on earth or rock and are pale green to yellowish green above, brownish below, to 1.5 cm tall. Leaves are to 3 mm long, crowded, crisped when dry, erect-spreading when moist, lingulate or linear from a widened oblong base. Leaf margins are entire, incurved towards the apex, with an obtuse and cucullate apex. The costa is excurrent into a short mucro. Upper lamina cells are  $\pm$  isodiametric and densely papillose; those at the leaf base are hyaline; thin-walled, rectangular, and extend obliquely up the margins.

Represented by three collections from the study area.

**Tortula muralis** Hedw., *Sp. Musc. Frond.* 123 (1801).

A moss that exhibits a strong preference for old, calcareous surfaces, plants form loose cushions on rock or stone and are particularly common on old cement and mortar. Stems are short, to about 5 mm long. Leaves are up to 3 mm long, oblong to oblong-lingulate, the apex obtuse or rounded, the margins revolute from the apex to well down the lamina. The costa is excurrent into a smooth, hyaline hairpoint. Upper lamina cells are subquadrate and densely papillose; those of the leaf base are rectangular, with a few marginal rows shorter and narrower.

Represented by 24 collections from the study area.

**Tortula recurvata** Hook., *Musc. Exot.* 2: 130 (1819).

*Desmatodon recurvatus* (Hook.) Mitt., *Fragm.* 11 suppl: 114 (1881).

Similar to *Tortula atrovirens* (Sm.) Lindb. but larger and darker green. Stems to 3 mm long. Leaves 1.5–3 mm long, to 0.7 mm wide, oblong to oblong-lanceolate, acute to acuminate; margins revolute towards the apex. Costa obscured by its papillose cells adaxially towards the distal part of the leaf, excurrent in a short mucro. Upper lamina cells are subquadrate, densely papillose, about 4–6 marginal rows not papillose; those of the leaf base are rectangular, with a few marginal rows shorter and narrower. Seta longer than in *T. atrovirens*, 1–2 cm tall; capsule also longer, to 2.4 mm long, dark brown. Occurs on soil and banks in moister habitats than *T. atrovirens* (Catcheside 1980), which has not yet been recorded for the Perth Region.

Represented by one collection from the study area.



**Trichostomum eckelianum** R.H.Zander, *Bull. Buffalo Soc. Nat. Sci.* 32: 92 (1993).

*Tortella cirrhata* Broth., *Nat. Pflanzenfam.* 1(3): 397 (1902), *vide* Zander, *Bull. Buffalo Soc. Nat. Sci.* 32: 92 (1993).

*Trichostomum cirrhatum* Hampe, *Icon. Musc.* 28 (1844), *nom. illeg.*

A common moss of sandy soils, plants form dense, yellow-green to green tufts on calcareous rock or soil. Stems are up to 2 cm tall. Leaves 2.5–3.5 mm long, crowded, crisped and glossy when dry, spreading when moist, linear-lanceolate to lingulate from a widened, hyaline, oblong base; apex narrowly acuminate; margins undulate, incurved in the upper half. The costa is strong and excurrent into a sharp point. Upper lamina cells are quadrate and densely papillose; basal cells are rectangular, hyaline, thin-walled, sharply differentiated from the papillose cells above and extend obliquely up the margins.

Represented by 14 collections from the study area.

**Triquetrella papillata** (Hook.f. & Wilson) Broth., *Nat. Pflanzenfam.* 1(3): 399 (1902).

Plants form loose, wiry patches of irregularly branched, yellowish brown shoots. The ovate-lanceolate leaves are 1–1.5 mm long, tightly appressed to the stems when dry, wide-spreading to squarrose when moist and then in three distinct rows with a slight spiral twist along the shoots. Leaf margins are variably recurved in the lower parts of the leaves. The lamina cells are small, rounded, densely papillose on both surfaces with 1 or 2 high, and often branched, papillae per cell.

Represented by two collections from the study area.

**Weissia controversa** Hedw., *Sp. Musc. Frond.* 67 (1801).

Plants are small, bright green or yellowish green and occur in dense turfs or cushions. The stems are erect, to 5 mm tall. Upper leaves are linear-lanceolate, concave, to 3 mm long, strongly crisped when dry, erect-spreading when moist. Leaf margins are plane below but strongly involute above. The costa is excurrent into a short mucro.

Represented by six collections from the study area.

**Weissia rutilans** (Hedw.) Lindb., *Öfvers. Förh. Kongl. Svenska Vetensk.-Akad.* 20: 417 (1863).

Plants are similar in appearance to *Weissia controversa* but grow in wetter habitats (Catcheside 1980). The leaves are oblong-lanceolate to linear-lanceolate and the margins are plane throughout. The costa is excurrent into a short mucro.

Represented by two collection from the study area.

## Racopilaceae

**Racopilum cuspidigerum** (Schwägr.) Ångstr. var. **convolutaceum** (Müll.Hal.) Zanten & Dijkstra, *Fragm. Florist. Geobot.* 40: 411 (1995).

*Racopilum convolutaceum* (Müll.Hal.) Reichardt, *Reise Novara* 1(3): 194 (1870).

Plants are dark green to yellowish green and form dense mats with the stems densely tomentose with brown rhizoids. The stems are irregularly sub-pinnately branched. The leaves are in four rows, with the two lateral rows larger, up to 2 mm long, oblong-lanceolate to oblong-ovate and more or less asymmetric. Leaf margins are plane and serrulate. The dorsal rows of leaves are smaller, ovate to ovate-cordate and have entire margins.

A type specimen was collected by F. Mueller in 1867 from the Porongorups, Western Australia.

Represented by 21 collections from the study area.

## Rhabdoweisiaceae

**Amphidium cyathicarpum** (Mont.) Broth., *Nat. Pflanzenfam.* 1(3): 460 (1902).

*Amphidium tortuosum* (Hornsch.) Cufod., *Oesterr. Bot. Zeitschr.* 98: 221 (1951).

Plants form dense pads on rock, up to 3 cm tall, with shoots bright green above and rusty brown below. The leaves are up to 3 mm long, very narrow, keeled and strongly curled when dry. The lamina cells are small, quadrate, thick-walled, with numerous rounded low papillae on both surfaces. Basal lamina cells are rectangular and thin-walled.

Represented by two collections from the study area.

## Sematophyllaceae

Sematophyllaceae is a large, species-rich and heterogeneous pleurocarpous moss family (Buck 1998) with around 53 genera (Buck 1982) and 600 species, best developed in tropical and subtropical regions (Tan *et al.* 1996; Ramsay *et al.* 2002). The family is characterised by having plants with leaves lacking a costa, linear or rhombic lamina cells, a well-differentiated alar region with the cells often seriate, inflated and vesiculose, stems often red and lacking a central strand, usually foliose pseudoparaphyllia, usually collenchymatous exothecial cells, and a double peristome. The family is, however, in need of much revisionary work (Buck 1998).

**Rhaphidorrhynchium amoenum** (Hedw.) M.Fleisch. var. **amoenum**, *Musc. Buitenzorg* 4: 1249 (1923).

*Sematophyllum amoenum* (Hedw.) Mitt., *J. Linn. Soc., Bot.* 12: 487 (1869).

Plants form dense, glossy, yellow-green to yellow-brown mats, usually on wood. The stems are up to 5 cm long, closely pinnately branched with lateral branches up to 1 cm long, and with dense tufts of rhizoids on the lower side. Leaves are ovate-lanceolate, acuminate, up to 1.5 mm long and less than 0.5 mm wide, and falcate to circinate or secund. Upper lamina cells are linear (L:W = 10–12:1), incrassate and porose. Cells at the leaf base are shorter and wider, yellowish, with a few alar cells inflated and hyaline, and with a small number of smaller and irregularly quadrate supra-alar cells.

Represented by two collections from the study area.

**Sematophyllum homomallum** (Hampe) Broth., *Nat. Pflanzenfam.* 2, 11: 433. (1925).

This is a rather xerophytic species often found on exposed rock, sometimes corticolous, and rarely in wetter habitats (Ramsay *et al.* 2002). Plants form dense, glossy, golden yellow to bronze-green or reddish mats. The stems are up to 3 cm long and irregularly pinnate. The leaves are ovate-lanceolate to oblong, short, bluntly acuminate, concave, markedly secund, erect, not falcate, 1.25–1.75 mm long, 0.5 mm wide, slightly concave and with entire margins. Laminal cells are somewhat thickened, incrassate, frequently porose and narrow-elongate (L:W = 8–10:1). The alar region has 3 or 4 rows of orange or yellow, quadrate, incrassate cells, with the basal row of 3 or 4 cells enlarged but not inflated, and quadrate supra-alar cells (Ramsay *et al.* 2002). The often shiny bronze colour is characteristic.

Represented by 32 collections from the study area.

**Sematophyllum subhumile** (Müll.Hal.) M.Fleisch. var. **contiguum** (Mitt.) B.C.Tan, W.B.Schofield & H.P.Ramsay, *Nova Hedwigia* 67: 219 (1998).

*Sematophyllum contiguum* (Mitt.) Mitt., *Fl. Vit.* 398 (1873).

Very close to *S. subhumile* var. *subhumile* and differing in the number of differentiated and inflated alar cells (Sainsbury 1955). The leaves have more acute apices than var. *subhumile* and the margins of the perichaetial leaves are serrulate. Ramsay *et al.* (2002) consider these taxa to be very close and there appears to be considerable variation in morphological characteristics.

Represented by six collections from the study area.

## Splachnaceae

Plants of the family Splachnaceae have mature capsules which emit chemical attractants to insects, which then disperse the spores to fresh dung.

**Tayloria octoblepharum** (Hook.) Mitt. var. **octoblepharum**, *Trans. & Proc. Roy. Soc. Victoria* 19: 65 (1882).

A moss found usually on old dung, but also sometimes on rotten wood or other organic substrates. It occasionally occurs on soil or rock. Plants usually form dense tufts. The leaves are pale green, 2–4 mm long and taper to a point. The capsules are borne on a stout, erect seta, and are up to 3 mm long, about 0.4 mm wide, with the spore-containing urn about 1/4–1/2 the capsule length.

Represented by two collections from the study area.

## Thuidiaceae

In their revision of Thuidiaceae in Australasia, Touw and Falter-van den Haak (1989) included *Thuidiopsis* (Broth.) Fleisch., within their concept of *Thuidium* Bruch & Schimp. Later, Touw (2001) recognised them both as distinct genera. That treatment is not accepted here. Distinguishing features of Thuidiaceae include the pinnate to tri-pinnate fronds, the abundant filamentous and papillose stem paraphyllia, the shortly mamillate or papillose lamina cells, and the leaves with a strong single costa.

The first specimen of a *Thuidium* from Australasia was collected by L. Preiss from 'Swan River province' (Touw & Falter-van den Haak 1989) and is now referred to *T. sparsum* (Hook.f. & Wilson) A.Jaeger var. *hastatum* (Mitt.) Touw & Falter-van den Haak.

***Thuidium sparsum*** (Hook.f. & Wilson) A.Jaeger. var. ***hastatum*** (Mitt.) Touw & Falter-van den Haak, *J. Hattori Bot. Lab.* 67: 24 (1989).

Plants are pale green to yellowish green, the branching mostly bipinnate. Stem leaves are 1.0–1.5 mm long, 0.8–1.0 mm wide, ovate-cordate to ovate-triangular to broadly triangular. Leaves of the ultimate branchlets are small, to 0.3 mm long, broadly ovate to ovate-oblong, the median leaf cells pluri-papillose

Represented by nine collections from the study area.

## Acknowledgements

We would like to thank Rod Seppelt for his invaluable input, and staff from the Western Australian Herbarium for their help and support with collection of specimens.

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